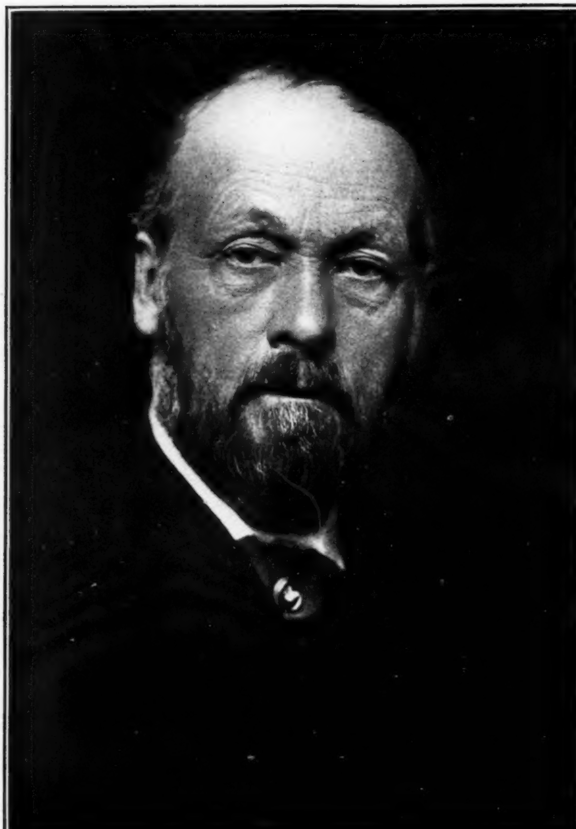
* For Indian stations a rain day is a day on which 0·1 in. [illegible] or more rain has fallen. † Mean of observations [illegible] from April, [illegible]

To face page 49.



G. C. Beresford, Photographers.

A rainfall observer for sixty-seven years.

WILLIAM S. CLARK.

The Meteorological Magazine

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The Propagation of Sound in the Atmosphere

By F. J. W. WHIPPLE, M.A., F.Inst.P.

SHORTLY after the termination of the War, Professor de Quervain of Zürich, suggested that the destruction of surplus explosives might be made to serve a good purpose by providing for explosions which could be made at set times and listened for by observers. In this way such theories as had been put forward in explanation of the anomalies of the propagation of sound in the atmosphere could be tested thoroughly. Professor de Quervain obtained the support of the International Commission for the Exploration of the Upper Atmosphere, and a Sub-commission was appointed at Bergen in 1921 to make such arrangements as should prove practicable. The first experimental explosion was produced at Oldebroek in Holland in October, 1922, and it has now been announced that there is to be a series of explosions during May, 1924, at La Courtine, on the Plateau des Mille Vaches, in the centre of France.

According to the interim report of the Sub-commission (presented to the International Meteorological Conference at Utrecht) the Oldebroek explosion was heard or registered instrumentally in south-east England, south Belgium, northern France, and, most unexpectedly, in Austria also. The "normal" zone of audibility reached only to a distance of 12 miles to the north-east and 40 miles to the south-west of the site of the explosion. Beyond the wide "zone of silence" the sound was heard at a distance of about 120 miles in the south-west and east. The greatest ranges at which records were obtained were about

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450 miles to north-west and 400 miles to west-south-west, and 350 to the south. These extreme ranges are greater than have been recorded for the audibility of natural explosions, with the outstanding exception of the eruption of Krakatoa, which was heard at 2,000 miles. The distance from La Courtine to the south coast of England is nearly 400 miles, so that, whilst it is very unlikely that the explosions produced there will be heard in this country, autographic records should be obtained. It would, perhaps, be practicable to use a device suggested* by M. Ernest Esclangon and recommended† by Professor Maurain. Esclangon uses a manometric flame: the jet, a short tube about 6 mms. in diameter, is mounted on the top of a petrol tin and ordinary lighting-gas is passed into the tin (presumably through another tube in the same cork) and out through the jet. The supply is adjusted to give a flame about 1½ inches high. Such apparatus is very sensitive to low sounds: it is anticipated that at 30 miles from the explosion the flame would be extinguished.

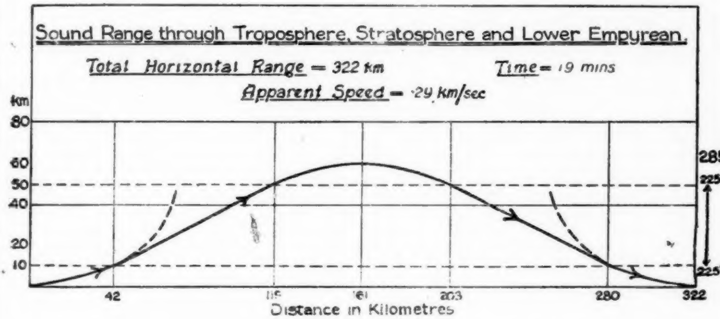
As to the theory of the curious disposition of regions of silence and audibility, which makes these experiments so interesting, some investigators have come to the conclusion that the phenomenon can be explained by the distribution of wind and temperature in the lower atmosphere. As a general rule, the information as to this distribution has been meagre. The advantage of direct experiment is that the conditions of the air up to reasonable heights can be determined at the appropriate time by appropriate observations. It is understood that in the case of the Oldebroek explosion Prof. van Everdingen finds that sound rays passing only through the lower atmosphere could not have reached some of the stations from which reports were received, notably those in England. The alternative explanation is that the sound traversed layers at considerable altitudes and returned to earth. The first theory of this kind was that of von dem Borne, who based his argument on the hypothesis that at great heights the principal constituent of the atmosphere was hydrogen, in which gas sound travels much faster than in ordinary air. The weakness of this theory lies in the fact that if such a hydrogen atmosphere does exist it must be so attenuated that the sonorous energy would be dissipated before it returned to earth. A more hopeful line of investigation was suggested‡ by the discovery by Lindemann and Dobson that the temperature of the part of the atmosphere where meteors become luminous was probably at least as high as that on the earth.

* *Paris, C.-R. Acad.sci.*, tome 178, 1924, p. 764.
† *La Nature, Paris* 52 (1) 1924, p. 177.
‡ F. J. W. Whipple. *Nature, London*, Vol. 112, 1923, p. 759.

Consider the course of a sound-ray through an atmosphere with the following distribution of temperature and uniform composition :—

At the ground ... ... 285° A. (54° F.)
Uniform lapse rate 0 to 10 km.
At 10 km. up ... ... 225° A. (—55° F.)
Uniform temperature 10 to 50 km.
At 50 km. up ... ... 225° A. (—55° F.)
Uniform negative lapse rate 50 to 60 km.
At 60 km. up ... ... 285° A. (54° F.)
Still higher temperature above 60 km.

The velocity of sound being proportional to the square root of the absolute temperature, it can be shown* that if the curvature of the earth be negelcted the shape of the sound-ray in the lowest section (the troposphere) will be a cycloid. A cycloid is the curve described by a particle on the edge of a rolling wheel. In this case the surface on which the hypothetical wheel rolls is at the height 47·5 kilometres, the height at which zero temperature would be reached if the uniform lapse rate, 6° per kilometre, persisted. In the stratosphere the sound-rays are straight. In the region of transition from the stratosphere to the Lindemann-Dobson atmosphere (which L. F. Richardson would call the empyrean) the ray will take the form of a cycloid with the concavity downwards, and, in favourable circumstances, the sound will pass back to the lower regions. The diagram



illustrates the case in which the ray is horizontal at both ends. The total range is 322 km., or about 200 miles. In passing through the troposphere the sound goes 42 km. horizontally and 10 km. vertically. Then in the stratosphere it goes 77 km.

* Horace Lamb. *The Dynamical Theory of Sound*, p. 216.

horizontally to 40 km. vertically. The vertex of the path is reached in another 42 km. The path is symmetrical about the vertex. The sound takes 19 minutes to complete this journey, whereas, if it could have passed along the earth's surface with the uniform speed appropriate to the temperature 285° A., it would have taken 16 minutes and arrived 3 minutes earlier. Rays which are steeper at the ends will penetrate further into the Lindemann-Dobson region and have a shorter range, but there will be a minimum range determined by the fact that temperature in the empyrean has an upper limit. In practice the pressure of wind and the irregularities in the lapse rate in the lower atmosphere must complicate matters, so that a symmetrical distribution of sound around the source is not to be expected. Reconciling the observations and constructing a consistent theory will require much patience and laborious computation. Let us honour the meteorologists who have undertaken the task.

In conclusion may I express again my opinion that the simpler way of obtaining information as to the speed of propagation of sound through the upper atmosphere, and thereby as to its temperature, would be to send up rockets such as Professor Goddard proposes to shoot at the moon. There should be no great difficulty in making at 50 or 60 km. a bang that could be heard on the ground.

Sun-Pillar Observations—March 13th, 1924

To observers who watch the sky carefully sun-pillars are not very rare phenomena. On most occasions, however, a sun-pillar would not be noticed by the inexperienced. The observations made on March 13th are noteworthy in that the majority were recorded by persons who had never seen such a thing before. Attention was called to the matter by a communication issued to the newspapers on March 14th, and reports from nearly 100 points have been received at the Meteorological Office. These points have been indicated on the map. One report has been received which shows that a sun-pillar was to be seen in the West of Ireland at sunrise.

> MARKREE CASTLE, SLIGO. "Sun-pillar observed on the morning of the 13th at sunrise. Formed a blood-red streak reaching about 5° or 6°. This phenomenon was beautiful and lasted for about five minutes."

In London there was very thick smoke haze all day and it was easy to watch the bright red sun as the time of sunset approached. It was therefore remarkable that the sun-pillar

could be seen at all. The following observations were made near Turnham Green station.

> "The sun-pillar was first noticed at 5h. 45m., when it formed a whitish vertical streak equal in width to the sun and reaching up to 5° above it. The sun's disc was strangely distorted before it disappeared at 5h. 49m. As the pillar moved northwards it became patchy and assumed a pink shade. It was last seen through the smoke haze at 6h. 9m., ten minutes after the time given for sunset in the almanack."

The following notes extracted from other reports show how the phenomenon varied: the height of the pillar being estimated as 30° in some places, at 5° in others, and the colours passing through different sequences. These notes are arranged in the order of the latitude of the stations.

CLOUGHTON, NEAR SCARBOROUGH. The sun-pillar was seen here on Thursday and also on a previous evening (Monday or Tuesday). We realised its beauty and not its importance as a phenomenon. The colour was rose-pink streaked with primrose yellow.

FOULBY (WAKEFIELD). A white beam of light 15° in height at 6h. 5m.

CAISTOR, LINCS. White column of light. Estimated height 30° to 45°. The sky was practically cloudless save just on the horizon itself.

SPALDING. A pale yellow beam of light pointing right into the sky. A streak of cloud seemed to sever it from the sun.

CRANWELL. First visible 5h. 25m., disappearing at 6h. The pillar extended 20° above the sun and ended in a point. White in colour but not dazzling. There was a little glitter but this was not pronounced. Sky cloudless except one-tenth cirrus on west horizon.

BOSTON. Turner never painted a sky like it. If it were produced on canvas, people would think it overdone. The pillar was perpendicular and of a delicate apricot tint.

NORTHAMPTON. Whitish yellow, 5° high at 6h. 5m.

FORNHAM (BURY ST. EDMUNDS). Decidedly yellow.

COTTON (STOWMARKET). At 5h. 55m. a white streak in the centre of a beautiful pink to gold cloud.

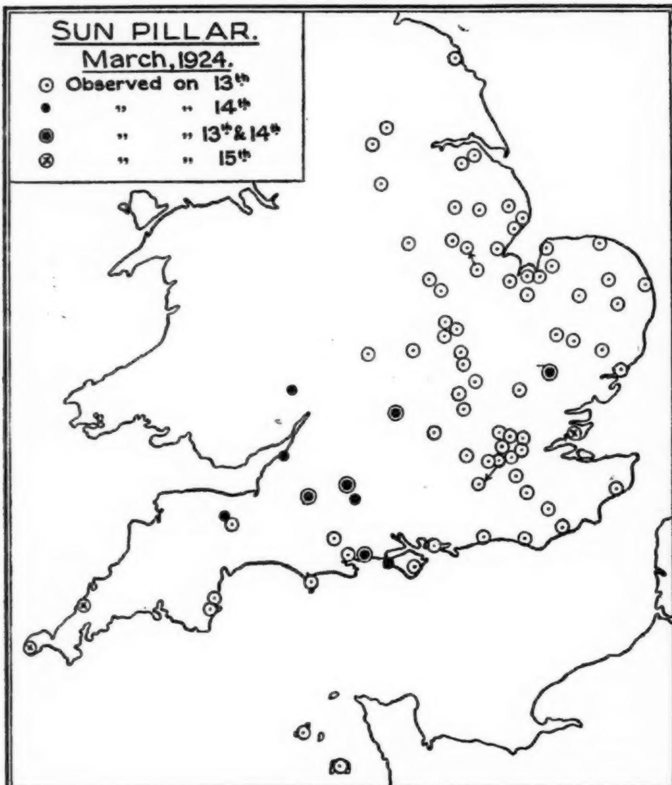
HITCHIN. At 6h. it extended upwards at least 30°.

GOLDERS GREEN (LONDON, N.W.). Soon after 5h. 30m. it came out of the sun's disc like a tree trunk, red-orange in colour, turning to gold, and then whiter until the top was lost in smoky clouds.

WOKING. The pillar was slightly divergent, and visible quite 20° above the horizon.

OXTED. Visible 5h. 15m. to 6h. 30m.

HOVE. 5h. 45m. to 6h., white, then yellow, then rose-tinted.
HAYLING ISLAND. The sunset took the form of a huge deep-pink cross.



PAIGNTON. Though the blue haze of an east wind veiled earth and sea, the sky was crystal-clear save for the flimsiest of drifting vapours. The pillar sprang into being about six without apparent reason. It changed from pale gold to opalescent pink and apricot.

GUERNSEY. After sunset the pillar was broader and shorter and shining with a warmer orange-gold glow.

We have to thank Prof. van Everdingen and M. Besson for the information that no reports of sun-pillars seen on the day in question have been received by the meteorological services in Holland and France. In Holland the sky was cloudless all day.

There were a few places, Oxford, Bruton and Highcliffe, at which sun-pillars were seen on the 14th as well as on the 13th. At Bruton that of the 14th was the finer. Between Ross-on-Wye and Totland Bay, there were five places where the phenomenon was reported only on the 14th. In Cornwall it occurred on the 15th. From Sennen, near Land's End, Mr. Ernest Heath sends a sketch in which the pillar is seen as pink with a yellow background. (The picture shows "patches of blood-red on the sea" difficult to explain "as there appeared to be nothing above which reflected anything like the colour.")

The general explanation of sun-pillars is well known; they are attributed to the reflection of light from the faces of ice-crystals. The analogy with the reflection of sunlight in the rippled surface of a lake is instructive. Such reflection gives a broad luminous path symmetrically placed with regard to the vertical plane through the middle of the sun. The parts of the reflecting surface are nearly horizontal: tipping, so to speak, fore and aft produces the length of the pathway, tipping transversely produces the breadth. It will be realised that the same amount of tipping is more effective in the one case than in the other, so that the apparent length of the pathway is much greater than its breadth. In the same way the dimensions of a sun-pillar are determined by the departure from the horizontal of the crystal faces from which the light is reflected. If when the sun is on the horizon the pillar reaches to an elevation 30°, there must be crystal faces making with the horizontal angles up to 15°. (The fact that on March 13th observers with experience in the measurement of angles estimated the height of the pillar as 30° is noteworthy. According to Pernter and Exner heights above 15° are exceedingly rare).

As to the form of the ice crystals which are responsible for the reflection which produces sun-pillars there appears to be no explicit information based on direct observation. On the other hand it is well known that the minute ice crystals, to which the name diamond dust has been given, are frequently in the form of flat hexagonal plates from $\frac{1}{2}$ to 1 mm. across. In Arctic regions such crystals fall slowly through the air without the sky being obscured. As they flutter downwards they will not remain horizontal. Some investigators suggest that the plates will mostly spin as they fall, but observations of other bodies falling in air or water suggests that the usual mode will be floating or oscillation about the horizontal. The growth of arms or spokes at the corners of the hexagons will have a steady-

ing effect. There is little doubt but that reflection of light from such flat crystals gives us sun-pillars.

As to the height above ground of the layer in which the diamond dust was prevalent on March 13th, and as to the depth of the layer, we are ignorant. It seems clear from the observers' reports that, though cirrus and cirro-stratus clouds were common, the sun-pillar was not formed by crystals in such clouds. Probably they were sparsely distributed through a great space. It may be added that over S. Farnborough an inversion of temperature was reported on March 13th, the readings being 39° F. at 3,100 feet, 45° F. at 5,200 feet. The freezing point was reached at 8,100 feet. This gives a lower limit to the height of the layer of reflecting particles. They cannot have persisted below 8,100 feet.

The question has been raised how frequently sun-pillars are to be seen in this country. Mr. Spencer Russell, who is making systematic observations of the characteristics of sun-rises and sunsets, has been so good as to communicate the following information based on his records during the last five years.

No. of Sun-pillars observed in London in 5 years.

	1919	1920	1921	1922	1923	Total
Sunrise ..	4	6	4	6	7	27
Sunset ..	4	5	3	8	11	31

	April	May	June	July	Aug.	Sept.	Total
Summer ½ year ...	4	10	8	4	3	2	31
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
Winter ½ year ...	4	2	6	5	5	5	27

Twice during the five years sun-pillars were recorded at consecutive times of observation, (1) at sunset on April 21st, 1920, and sunrise April 22nd, and (2) at sunrise on December 24th, 1921, and sunset on the same day. In June, 1920, sun-pillars were observed at two consecutive sunrises.

Finally, let us note for future reference that on this occasion, at any rate, sun-pillars appeared in the middle of a spell of fine weather.

Discussions at the Meteorological Office

March 17th, 1924. *An aerological survey of the United States. Part I., Results of observations by means of kites.* By W. R. Gregg (M.W. Rev. : Supplement No. 20, Washington, 1922). *Opener*—L. H. G. Dines, M.A.

The paper under discussion is a valuable contribution to the study of the upper air. The results are not conspicuously different from those obtained in other parts of the north temperate zone.

March 31st, 1924. *Radiative Equilibrium ; the Insolation of an Atmosphere.* By E. A. Milne (Phil. Mag., Vol 44, 1922, pp. 872-896). *Opener*—M. A. Giblett, M.Sc.

The paper which formed the subject for discussion at this meeting constitutes the second important advance which has been made in our theoretical knowledge of radiative processes in the atmosphere, particularly as bearing on the existence and maintenance of the earth's stratosphere, since the pioneer work of Gold in England and Humphreys in America, about the year 1908. Apart from the principal discovery, that the stratosphere can only be explained in a rational physical way when radiation processes are taken into account, the result of Gold's, which is of greatest interest in the present connection, is that the greater the amount of water vapour in the atmosphere, that is the greater its opacity to the long-wave atmospheric radiation, the higher must be the dividing level between the lower convective atmosphere and the outer shell which is in temperature equilibrium under the action of radiation alone ; that is, the higher the tropopause. The observed latitude variation in the conditions of the stratosphere was thus explained, but the astonishing deduction followed, that the net outward flux of atmospheric and terrestrial radiation to space across the outer limit of the atmosphere must be actually less in equatorial regions than in higher latitudes. One assumption made in the investigation was that the atmosphere is "gray," *i.e.*, has, in each layer, an absorption coefficient the same for all wave lengths that are important. Gold suggested, without analysis, that the atmosphere is probably transparent in certain important spectral regions, thus allowing for the escape to space of extra radiation, so avoiding the necessity of accepting the above result.

Humphreys, in the course of his work, arrived independently at a useful relationship, which had been obtained earlier by Schwarzschild in connection with stellar atmospheres. Briefly, in its application to the earth's atmosphere, it is this : that,

neglecting direct absorption by the atmosphere of incoming solar radiation, the temperature, T_0, assumed by the outer layers of the atmosphere, is related to the "effective temperature," T_1, of the system earth plus atmosphere, by the simple relation $T_0 = T_1 / \sqrt[4]{2}$. The "effective temperature" is simply the temperature of a "black" surface, or full radiator, which would yield a total radiation, per unit area, equal to that which the earth and atmosphere together deliver to space, across unit area of the outer boundary. The effective temperature, T_1, is actually about 254°, giving T_0, the temperature of the stratosphere, as 214°, in very good agreement with average observed values. It should be noticed that the above relation is quite independent of the way in which the absorption coefficient varies from layer to layer of the atmosphere.

The first important step taken after this early work, was by Emden in 1913. This paper was brought forward by Col. Gold at a Meteorological Office Discussion in March, 1921*. Emden asked the question: What temperature distribution would a stratified medium such as the atmosphere assume and maintain under the continual influence of radiant energy impinging from without on to its outer boundary ? The application of Emden's work is restricted owing to his having taken the incident radiation as arriving uniformly from all directions instead of entering the atmosphere along rays at some particular inclination, so that he was not in a position to consider the effects of latitude. Now Milne asks a similar question, but removes this restriction and takes into account the angle of incidence of the solar beam. When the sun is in the zenith the greater part of the thermal energy gets through to the surface of the earth, and the atmosphere is heated from below. When the sun is near the horizon the greater part of the energy is absorbed before it reaches the surface of the earth and by this absorption the air gains heat. It is assumed that there is in each stratum of the atmosphere, one coefficient of absorption for long waves and another for solar radiation, the latter being only a fraction of the former, this fraction, which Milne calls n, having the same value at all levels.

Milne's answer to Emden's question is very striking. Interpreting the results in relation to the earth, it appears that the state of radiative equilibrium would be such that temperature at the outer boundary was quite independent of the absorption properties of the strata and is determined only by the solar constant, the latitude and the coefficient n.† From this outer boundary temperatures would increase inwards. The temperature assumed

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* *Meteorological Magazine*, Vol. 56, April, 1921, p. 68.

† This constitutes an important extension of the Humphreys-Schwarzschild case mentioned above.

by the earth's surface would be higher than that of the lowest stratum of air. It is clear that if other modes of heat transference than radiation were allowed to operate, convection would ensue ; so that an atmosphere in strict radiative equilibrium throughout is not possible. Quite apart from this, the lapse rate of temperature for radiative equilibrium might exceed the dry adiabatic rate (as indeed Emden showed it would up to 3 km. in the case he considered), giving an extra reason for convection in the lower atmosphere.

On the poleward side of a certain critical latitude, conditions are reversed, temperature appropriate to radiative equilibrium decreases as the earth's surface is approached, and the surface itself is colder than the air in contact with it. In the critical latitude, conditions are isothermal throughout. If solar radiation were absorbed as readily as atmospheric this latitude would at the equinox be 45°. Greater transparency to solar radiation displaces the critical latitude rapidly towards the pole.

Milne wishes to insist principally on the general theory, any application being made only tentatively and being valid only within the range of the assumptions made.

The chief application is to the latitude variation of conditions in the stratosphere. In the work outlined above, the temperature of the equatorial stratosphere comes out much higher than that in higher latitudes, which is contrary to observation. The greater obliquity of the incident solar beam in high latitudes does indeed make the difference between the temperature at the equator and at the poles less in the stratosphere than lower down in the atmosphere, but it by no means reverses its sign. It is suggested that on account of the relatively greater importance of carbon-dioxide compared with water vapour the coefficient n may be greater in high than in low latitudes. This would further reduce the contrast.

But to obtain a cold equatorial stratosphere and a warm polar one it becomes necessary to suppose that some of the solar energy incident in equatorial latitudes is re-radiated to space in higher latitudes, *i.e.*, the general circulation of the atmosphere must be brought in, and, indeed, to such an extent as to lead to the same result, as Gold obtained, viz., that the earth and atmosphere together return to space less radiation in low latitudes than in high.

Observations gave us the paradox that the higher atmosphere was colder over the equator than over the poles ; theorists now agree in presenting us with another paradox, the strongest radiation into space is from the coldest parts of the globe. The search for a complete explanation of these paradoxes is one of the most fascinating tasks before meteorologists.

M.A.G.

Royal Meteorological Society

THE meeting of the Society held on Wednesday, March 19th, at 49, Cromwell Road, South Kensington, was devoted to the customary March lecture ; Capt. C. J. P. Cave, President, in the Chair.

Professor V. D. Blackman.—Atmospheric Electric Currents, normal and abnormal, and their relation to the growth of plants.

The first part of the lecture was devoted to the history of the subject. Reliable determinations of the effect of electric conditions on the growth of plants are difficult as the elimination of other factors is only possible when the experiments are numerous and statistical methods can be used. In the earlier experiments this was not clearly understood, and accordingly divergent results were obtained and the optimistic claims of one author could not be upheld by the next. In recent years field experiments, made with all precaution at Rothamsted and other agricultural stations, have shown that a small but definite increase of the crop is found when cereals such as oats are given daily doses of electric current. Professor Blackman and his collaborators recognised, however, that they were working in the dark in varying the strength of the dose and the time at which it should be given and that it would be more economical to work on a small scale, growing plants in pots with all the conditions under control. The new experiments have shown that the best results are obtained with exceedingly small doses and that the susceptibility of the plants varies at different stages of growth. In the latest experiments a single plant is under observation, a barley plant a few hours old : it is found that if the electric current is given for half an hour the effect of the stimulus is shown by more rapid growth during the next ten hours.

Whether the changes in the natural electrical state of the atmosphere produce any effects on plants is still an open question : but the growth of knowledge of the action of artificial stimuli will no doubt provide an answer before long.

Aeroplanes have been used to obtain information and to prevent further loss of life on the banks of the Vistula, where near the end of March more than 40 villages were under water and several bridges have been carried away. Icedams, which had formed across the river owing to the sandbanks, have been broken up by artillery fire.—*Daily Mail.*

Correspondence

To the Editor, *The Meteorological Magazine*

The Long Arm of Coincidence

I WAS interested in the paragraph appearing under the above heading in the February number of the *Meterological Magazine*. May I give further instances; this time concerning the element of bright sunshine. At Ross-on-Wye in 1922 the total sunshine was 1,454 hours; in 1923, 1,455 hours: the figures in each case being rounded off to the nearest whole number by the Air Ministry. The actual difference between the two totals is about half-an-hour! Again, the sunshine registered here in February, 1924, was 62·8 hours, and in January, 1924, 62·7 hours! A year ago the February total was 63·3 hours; roughly, 63 hours in each instance.

F. J. PARSONS.

County Observatory, Ross-on-Wye, March 6th, 1924.

Another curious example of the above. On January 1st, 1915, I measured at 9 a.m. the December rainfall 6·20 in., the highest I had recorded since 1880, when I began observing at Colwyn Bay. On January 1st, 1916, I measured 6·18 in.! And it began to rain while I was measuring, so that in a few minutes it would have been exactly the same for 1914 and 1915.

ALFRED O. WALKER.

Ulcombe, Kent, March 20th, 1924.

[The instances quoted by Mr. Parsons and Mr. Walker show how the meteorological conditions of one year may resemble those of another without the recorded figures tallying exactly. If there is a group of 100 stations at each of which the difference between the rainfalls of two consecutive years is less than 1 inch, then it is highly probable that at one station the difference recorded will be zero. To the observer at that station it is a remarkable coincidence, to the statistician it is a commonplace.—ED. *M.M.*]

The Severe Winter in Greece

I HAVE recently seen in the newspapers notices of very severe weather lately experienced in Greece, of heavy snows, of a train snowed up between Athens and Thebes (in some mountain pass, I presume): and I have just heard from an old friend at Patras, who has lived there nearly 60 years, that the winter has been the most severe that he has known; but he does not give any figures.

It happens that just 50 years ago, in February and March, 1874, I was recording at Patras some very low temperatures. These were published in the *Quarterly Journal of the Meteorological Society* in July, 1877. I may quote as follows :—

> 1874. *Snow.* On the morning of Feb. 2 snow lay alike on mountain and plain all round, all but down to the sea level, and snow flakes fell that afternoon in the streets of Patras. Snow fell again in the town in the afternoons of Feb. 5 and 11 ; on the latter of these days in prodigious quantities among the mountains. Flakes fell again on March 1 and 4, and on March 5 snow fell heavily on the deck of a steamer between Zante and the Morea. On March 7 a climax was reached with light wind, brilliant sunshine and wonderfully transparent air—ground at all sheltered from the sun as also my wet bulb thermometer continued hard frozen all day "

Little as would be thought of this " worst " in England, be it remembered that for a seaside station in the Mediterranean, in latitude 38°, this was intense severity. Not only was the havoc fearful among the flowers, hedges of geranium, etc., but scarce a lemon tree escaped. Old trees had to be cut down to mere stumps and the next autumn lemons cost nearly as much in Patras as in London!

H. A. BOYS, F.R.Met.Soc.

Spring Hill, S. Mary Bourne, Andover. March 5th, 1924.

Long Records

" I notice in the Obituary, in the 1922 volume of *British Rainfall,* the death of Rev. John Dene, who had a record of 50 years' rainfall, and that you only know of one living observer (Sir John Moore) with so long a record. Further, that the late Mr. Dalgleish kept a record of 57 years. As I began in June, 1863, and have completed 60 entire years, 1864-1923, I flatter myself I have done still better.

" I have worked out my 60 years' averages and find most months fairly in agreement with the 1881-1915 averages. Jan., May and Sept., however, come out 10 or 12 per cent. higher, and June lower. My first 10-year average gave Jan. as high as 3·31 in. and May 2·28 in., June on the other hand only 1·38 in., and my last 10-year average puts June down to 1·07 in. and Dec. up to 3·82 in."

J. ELLIS MACE.

View Tower, Tenterden, February 2nd, 1924.

[We are glad to take this opportunity to congratulate Mr. Mace on his record and to mention that there is at least one observer whose observations cover a longer period than his—Mr. W. S. Clark, whose portrait appears in this issue of the *Meteorological Magazine.*—ED. *M.M.*]

Visibility and Convection

On p. 436 of " Forecasting Weather " (second edition), Sir Napier Shaw says: " On the other hand, cyclonic weather with its strong convection is from that point of view good for seeing, and the appearance of cumulus clouds in the sky ought to be a good sign, as showing that there is at least some convection there."

I have examined the relationship between upward convection currents from the ground and the degree of horizontal visibility, using the summers (the six months from April to September) of 1920 to 1923 (inclusive), and the observations made at Cranwell, Lincolnshire. The results may not be without interest.

The visibility observations made each day at 13h. were classified under three headings:—

(A) Those in which the visibility was 13 miles or more, termed hereafter " good or very good,"

(B) Those in which the visibility was $2\frac{1}{4}$ miles or over, but not reaching 13 miles, termed hereafter " indifferent or fair,"

(C) Those in which the visibility was less than $2\frac{1}{4}$ miles, termed hereafter " bad or poor,"

and then further classified as to whether or no convection was present, as determined by the existence of cumulus or cumulonimbus cloud at the time of the visibility observation.

The results are shown in the following Table:—

Cu. or Cu-Nb.	Total No. of obs.	GROUND VISIBILITY.		
		Good or very good	Indifferent or fair	Bad or poor
Present	467	41 %	59 %	0.2 %
Absent	265	21 %	75 %	4 %

A consideration of this table seems to justify the belief that convection days are more likely to be accompanied by good or very good visibility than are non-convection days, and are very unlikely to be accompanied by bad or poor visibility.

W. H. Pick.

R.A.F. (Cadet) College, Cranwell, Lincs., March 6th, 1924.

[It is to be hoped that such analysis as has been undertaken by Captain Pick will be carried further. It is not entirely satisfactory to class with the days of no convection those with a cloudless sky when distant objects are " all a-shimmer in the haze."—Ed. *M.M.*]

OFFICIAL NOTICES

The Height of Low Clouds

INFORMATION as to the height of the lowest clouds is of great importance in the navigation of the air. Such information has been included in meteorological telegrams for some years, having been introduced in the British Army in France during the War. It is usually obtained either by a pilot balloon observation or by estimates based on experience with such observations.

It has now been arranged that at the stations where a professional staff is maintained by the Meteorological Office, the height of the cloud at each of the daylight hours of observation in the standard scheme, viz., 7h., 13h. and 18h. G.M.T., shall always be determined either by a pilot balloon or by sending up a smaller balloon specially for the purpose.

Reports of Cloud Amounts

THE Meteorological Conference at Vienna in 1873 resolved that "The degree of cloudiness is to be given by the figures 0-10, in which 0 is to represent a sky quite free from cloud, and 10 an entirely overcast sky." This resolution has not always been set out sufficiently clearly in instructions to observers, who have consequently been in doubt as to what was the appropriate entry on occasions when the sky was almost, but not quite free from cloud, or almost, but not quite overcast. Instructions have recently been issued to the observers of the Meteorological Office which may be summarised as follows :—

In every case when there is cloud present the fact must be reported. The entry 0 for cloud must only be used when the sky is quite free from cloud. Where a very small amount of cloud occurs it should be reported as amount 1, so that 1 is to be interpreted as meaning some cloud and not more than three-twentieths of the whole sky. At the upper end of the scale of cloud amount the rule is that in every case when there is any clear sky visible the fact must be reported. Cloud amount 10 must only be used when the sky is quite overcast with no patches of clear or blue sky visible at all. If cloud covers more than seventeen-twentieths of the sky and does not completely cover the sky it is to be counted as amount 9. These instructions are to be read in conjunction with the decision* that when the whole sky is covered by a thin veil of cloud, through which the sun or the stars can be seen faintly, the cloud amount is 10.

* *Meteorological Magazine*, Vol. 57, 1922, p. 267.

NOTES AND QUERIES

The Government's Appreciation of the Work of Meteorological Observers

In introducing the Air Estimates in the House of Commons on March 11th, 1924, the Under-Secretary of State for Air (Mr. Leach) referred to the Meteorological Service in the following words :—

"MAY I say a word now about a Department of which I am rather proud ? By arrangement made some five years ago, the Air Ministry provides the meteorological service of the whole country. The importance of this Department is not sufficiently realised. The public thinks of it in terms of daily newspaper weather forecasts, but its chief work is connected with aviation, shipping, agriculture, public health, and military and naval services. It is a mighty and beneficial international engine. Co-operative observations are taken simultaneously all over Europe. These are collected at a few centres and broadcasted by wireless telegraphy. Almost at once every meteorological office in Europe knows weather conditions from Spitzbergen to Cairo, and from far out in the Atlantic to Ekaterinburg. As an instrument for prevention of accidents in aviation, it is a splendid life-saving agency. Moreover, 4,000 public-spirited observers all over the country supply us voluntarily with rainfall records ; 255 of our 306 climatological stations are maintained at the cost and trouble of scientifically-minded private citizens ; and 500 scientific officers on board our merchant ships supply us with observations from all parts of the world. Our own staff is only 270 alert, competent people doing valuable scientific work. Our debt, therefore, to this voluntary army of public-spirited people is incalculable, and may I take this opportunity of expressing the gratitude of Parliament to them ? In two Votes £119,000 is put down for this work. After deducting receipts, £12,500, the net cost is £106,500—a remarkably cheap and productive investment."

Radiation from the Atmosphere.—A Correction

IN the note on Professor Vegard's hypothetical nitrogen nuclei in the last number of the *Meteorological Magazine* the statement was made that the radiation which left the atmosphere was in the main emitted by the stratosphere, "a source at about 220° A." This statement is not justified : it is probably true that little of the radiation from the ground escapes without being absorbed by the water vapour in the air, but it must not be forgotten that the water vapour is itself radiating. When radiative equilibrium is reached every layer re-emits all the

energy it absorbs, the net flux then being the same through all layers. It cannot therefore be said that the radiation which passes out of the atmosphere originated in any particular layer.

The net flux is equal, however, to the total radiation from a black body at about 254° A., and a small black sphere subject to such radiation from one direction would reach a steady temperature $254° \div \sqrt[4]{2}$ or 214° A. It is hardly necessary to add that this amendment of the argument increases the difficulty in accepting Vegard's hypothesis.

The Parkin Prize

THE following notice has been received from Dr. J. S. Fowler, Secretary of the Royal College of Physicians of Edinburgh :—

> In terms of the Bequest made to the Royal College of Physicians of Edinburgh by the late Dr. John Parkin, Fellow of the College, a Prize is offered for the best Essay on certain subjects connected with Medicine.
>
> The subject of the Essay for the present period is, in the terms of the deed :—
>
> "On the effects of volcanic action in the production of epidemic diseases in the animal and in the vegetable creation, and in the production of hurricanes and abnormal atmospherical vicissitudes."
>
> The prize is of the value of One Hundred Pounds, and is open to Competitors of all Nations.
>
> Essays, which must be written in English, must be received by the Secretary not later than December 31st, 1924. Each Essay must bear a motto, and be accompanied by a sealed envelope bearing the same motto outside and the author's name inside.
>
> The successful Candidate must publish his Essay at his own expense, and present a printed copy to the College within three months after the adjudication of the Prize.

We understand that only twice when Volcanic Action has been the subject set for the Parkin Prize has an award been made. In 1900 the prize was divided between W. G. Aitchison Robertson and Noel Dean Bardswell, and in 1913 H. J. Johnston-Lavis was the prize winner. The publishers of the three prize essays were G. R. Hamilton, Edinburgh, the *Edin. Medical Journal* (Oct. 1901), and J. Bale, Sons and Danielsson, London, respectively.

We regret to learn of the death on March 16th of M. Alfred Angot, late Director of the Central Meteorological Bureau, Paris, and for many years a member of the International Meteorological Committee.

A Rainfall Observer for Sixty-seven Years

MR. W. S. CLARK, whose portrait we are glad to reproduce in this number of the *Meteorological Magazine*, is the senior observer reporting to the British Rainfall Organization. He started rainfall observations in 1857, being then nineteen years old. He was then living in the centre of the Village of Street, Somerset. He has moved twice, to the next house in 1866, and in 1890 to his present residence three-quarters of a mile from the village; otherwise the rainfall observations for the whole period are homogeneous; they have appeared regularly in *English Rainfall* and its successor *British Rainfall* from 1860 onwards. It is to be hoped that the complete set of monthly totals will be published.

Jan Mayen

A FURTHER extension of the activities of the Norwegian Meteorologists stationed on the Island of Jan Mayen was indicated on March 18th, when for the first time reports, giving the upper winds as determined from observations of pilot balloons sent up on the island, were received in this country from Norway in wireless messages. Two ascents were made on that day, the first reaching 6,500 ft., the second nearly 20,000 ft.

The reports from Jan Mayen, which it will be remembered is in latitude 71° N, well within the Arctic Circle, have already proved of great value to the forecasting service.

Meteorological Free-Ballooning in the United States

BELIEVING that the scientific possibilities of the manned free balloon have not been exhausted, the United States Weather Bureau, in co-operation with the Army Air Service, is undertaking a series of flights for meteorological purposes. It was arranged that these flights should take place during the months of April and May, the starting point in each case being Scott Field, Illinois, the Army's large lighter-than-air post near St. Louis, Missouri. The balloons are of the standard training type, 35,000 cubic feet capacity, and filled with hydrogen. Two men are to make the flights—one an Air Service officer, to act as pilot, and the other the representative of the Weather Bureau.

Dr. C. Le Roy Meisinger, who has been nominated by the Chief of the Weather Bureau to represent the Bureau on these flights, has been so good as to write out for the *Meteorological Magazine* the following notes on his programme.

While there are several objects in making these air voyages, particular attention will be given to the determination of free-air trajectories from the course taken by the balloon riding at relatively constant elevations. The problem resembles that

studied by Shaw and Lempfert with respect to surface air, and published as *The Life History of Surface Air Currents.* It is recognised that convective effects may, in some cases, act as a deterrent to the attainment of this object ; but, in general, it is believed that a fair representation of the path of a given mass of air can be obtained in this way. It is required, therefore, to know as accurately as possible the horizontal trajectory of the balloon itself. This affords little difficulty when the ground can be seen ; but when the earth is obscured by clouds recourse will be had to dropping attractively colored postcards, speeded by small lead weights, which may be picked up and mailed. These cards contain spaces to be filled in by the finder showing the place and time of finding. Astronomical observations of position above clouds by means of an aircraft sextant will also be made when circumstances require.

A number of stations in the United States have been provided with tables for the reduction of barometric pressure to levels 1 and 2 kilometres above sea-level, according to a method recently developed*. Trajectories of air worked out upon the basis of these charts, and gradient wind relations, will be compared with those determined by observation from the balloon.

An Owens Dust Counter will be carried, at the suggestion of Dr. H. H. Kimball, who has had charge of the atmospheric dust observations in the United States, agreed upon internationally at the Rome meeting in 1922. Also, observations of sky brightness at several points in the sky will be made by means of a Holophane Lightmeter—a commercial portable photometer. Aside from the carrying of a carefully calibrated and accurate barograph (in addition to the usual balloon instruments) and an Assmann aspiration psychrometer—the latter principally for temperature observations—little attention will be paid to the observation of the vertical distribution of meteorological elements, for kites and pilot-balloons are in daily use at a number of stations, and it is believed that their testimony is of a higher order of accuracy than is obtainable in a manned balloon.

Some attempt will be made to measure the size of water droplets in clouds by means of the measurement of the angular diameter of coronas formed about small electric lights. But since preliminary experiments have not been wholly satisfactory, further trials must be conducted before good results are assured, and these trials can best be made actually in the clouds.

Close liaison will be maintained between the balloonists and the forecast officials in Washington. The latter will be informed

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*Meisinger, C. LeRoy: The preparation and significance of free air pressure maps in the Central and Eastern United States. *Monthly Weather Review Supplement, No.* 21. Washington, 1922.

at all times of the departure and landing of the balloonists; and, while the balloon is in the air, special weather bulletins will be broadcasted by radiotelephone from several commercial broadcasting stations that have volunteered to co-operate. The balloon will be equipped for radio reception, but not for transmission.

The High Fog in London on January 23rd, 1924

JANUARY 23rd was marked by a smoke fog of an abnormal character in London and surrounding districts. The amount of impurity registered by the automatic filters in Westminster and South Kensington was not unusually large, but a thick bank of smoke overhead seriously obscured the daylight in most parts of London, light conditions about mid-day being similar to those during the night.

In Westminster the really abnormal conditions commenced at about 11 a.m., before which time the morning was dull and the sky overcast. From 11 a.m. to 1 p.m. light failed gradually until the whole of the sky visible from the window of Dr. Owens's Office in Victoria Street was completely black, the darkness appearing to spread from a northerly direction: nevertheless, shop window lights could be readily seen in the street approximately a quarter of a mile away, indicating that surface visibility was still comparatively good.

At 1.10 p.m. the sky towards the north became slightly luminous and of a rosy colour, but the south was still black. From this time the sky cleared from the north. About 1.30 p.m. an intermittent noise very much resembling distant thunder was heard. During the next few minutes the light improved considerably. At 1.45 p.m. a shower of very fine rain commenced, and clouds of white mist could be seen blowing past the Victoria Street buildings towards the south. Conditions then came back practically to normal, with some fluctuations apparently caused by the indeterminate wind which arose. About 1.55 p.m. there was a particularly bright period, but at 2.5 p.m. the sky in the north had darkened again. At 3.5 p.m. the haze was white, rain was falling steadily, the wind was very indefinite, and the sky was lighter. As the daylight failed towards evening, conditions seemed to follow exactly those experienced from 11 a.m. onwards, and at 5.35 p.m. everything appeared the same as at 1 p.m.

Enquiry as to the limits of the area affected by the high fog have been made through various channels. It appears that fog did not extend to the north of Finchley Road. In the south some fog was general, but the extent to which it partook of the special character observed at Westminster cannot be deter-

mined. The amount of smoke in the air as measured by the air-filter was not exceptional. At Westminster the maximum for the day, 7 milligrams per cubic metre, occurred as early as 9.50 a.m. During the dark period the amount was about 4 mg/m^3. At South Kensington the amount was only 2 mg/m^3.

The circumstances in which this high fog developed have not been determined in such detail as would enable us to answer with any confidence the question why it occurred. It is unfortunate that no observations of upper air temperature over England were secured. There were observations in the Low Countries, but these were made in an air current from the east, whereas the air over south-east England was drifting from the north. It was air which had travelled from the south, having left the Atlantic two or three days previously and traversed Spain and France. It had almost come to rest during the night January 22nd-23rd. There is some evidence that the air at such heights as 3,000 ft. had left the Atlantic further south than the surface air, and therefore that it probably contained more water vapour. The current of cold air from the Continent touched the east coast of England but it did not reach London, where temperature was very steady, rising only from the night-minimum of 44° F. to the day-maximum of 45·5° F. This steadiness is to be attributed in great part to the presence of a layer of low stratus cloud: the height of the cloud was given at several stations as about 200 feet. It would seem that as the cloud drifted slowly over London it was contaminated by the smoke and that the smoke-laden cloud cut off the daylight. There seems to be no direct experimental evidence that a cloud of dirty drops cuts off more light than a cloud of clean drops, and, indeed, it is not known that smoke does mix with the water of minute drops. On the other hand in this case the light seems to have been cut off much more effectively than it would have been by two separate screens, one of cloud, the other of smoke.

The essential features of the phenomenon appear to be:

(*a*) Very slight air movements.

(*b*) Persistent low cloud.

The Demand for a Clean Atmosphere

THE Annual Meeting of the Coal Smoke Abatement Society was held at the Royal Society of Arts on March 26th. Lord Newton, who presided, insisted on the bad effects of smoke on the health of the community, and on the unnecessary labour involved in the removal of the soot deposit which in the case of London amounted to 300 tons a year. Mr. G. B. Shaw made a forceful speech. Some of his points were: "London is chock full of beautiful things but unfortunately we have not light to see them,

because of the smoke and fog and grime. I know Englishmen always like to be washing, but, as an Irishman, I dislike it intensely. Yet, in London, I am always washing my hands." What was required was a sort of civic consciousness in the matter. No mediæval person would live in our modern disgraceful towns. Sir Napier Shaw recalled with satisfaction the progress that had been made in the problem of providing pure water. Recollections of the sacrifice of valuable lives had stimulated the efforts to obtain pure water. Was it needful for lives to be publicly offered in sacrifice in order to achieve pure air? Was not the obvious sacrifice of comfort, health and vigour enough? As to the mode of remedying the nuisance the difficulty was that statutes of prohibition raised as many obstacles as they removed. The right way was to find some means of making it worth while for the landlord, the tenant and the household to agree among themselves upon arrangements for the avoidance of smoke. Dame Helen Gwynne-Vaughan and Dr. H. A. Des Vœux also spoke.

On April 3rd a deputation, headed by Lord Newton, waited on Mr. Wheatley, the Minister of Health, to urge the need for legislation to secure smoke abatement. The Minister promised to facilitate educational work and to give sympathetic consideration to the request for the early introduction of a Bill in Parliament.

One of the ways in which the smoke problem may be solved is shown by the issue of the prospectus of "Leigh Smokeless Fuels, Limited." This company has been formed to work processes patented by Mr. E. R. Sutcliffe for making from coal dust a fuel with all the virtues of anthracite. To quote from one of the testimonials in the prospectus, "The fuel is wanted and wanted now."

News in Brief

Sir Napier Shaw will deliver a course of five lectures on Radiation at the School of Meteorology, South Kensington, during the summer term. The lectures will be on Fridays at 3 p.m., beginning on Friday, May 9th, 1924. Anyone wishing to attend should apply to the Registrar, Imperial College of Science and Technology, South Kensington, S.W. 7. The fee for the course is 15s.

The synoptic messages issued by wireless telegraphy from Rome have been expressed in the new International Code since February 21st, 1924. Since March 2nd the times of issue have been considerably accelerated. The morning message is now issued at 8h. 50m. and the evening message at 19h. 50m. G.M.T.

It is announced that Boris Weinberg, Professor of Physics at the University of Tomsk from 1905 until recently, has been appointed Director of the Russian Central Physical Observatory. He is best known for his share in the Magnetic Survey of Siberia, but he has also done a good deal of work on anchor ice, surface tension and the formation of snow crystals.

The Weather of March, 1924

For the first four or five days of the month the air supply over the British Isles was drawn from the Arctic regions and northern Europe, and temperature fell even lower than in February. On the 3rd a minimum of 2°F. in the screen and of —2°F. on the ground was recorded at Balmoral. Snow and hail occurred at several places, and in many parts of the country snow lying to a depth of several inches was reported. Pressure rose quickly over England and the adjacent parts of the continent about the 6th of the month, and, with the change to fine sunny weather, there was a gradual increase in day temperatures, 63°F. being recorded at Killarney on the 15th. The nights, however, continued cold and thermometers exposed on the grass frequently fell below 20°F. As an instance of the persistence of cold weather it may be mentioned that at Copdock, Ipswich, the grass minimum thermometer gave readings of 32°F. or below on each of 39 nights from February 12th to March 21st inclusive. Sunshine records were repeatedly good, and during the first three weeks 9 or 10 hours were registered on most days in some part of the kingdom. Such conditions when combined with light winds naturally favoured a wide daily range of temperature; ranges of 30°F. and even 40°F. (S. Farnborough on the 15th) being recorded in some parts of England. At the same time at one or two places, notably in Scotland and Ireland, the conditions were cloudy and the range only amounted to 2°F. or 3°F. Little rain fell between the 6th and 20th, and in some parts of England there was an absolute drought during this period. After the 20th, however, depressions from the Atlantic spread across the British Isles and south-westerly winds with mild rainy weather prevailed in the south; on the 22nd 41mm. were recorded at Treherbert (Glamorganshire) and 37mm. at Llyn Fawr Reservoirs (Glamorganshire). In the north snow or hail occurred. During the last week winds were between E and NE and the weather cold and cloudy with showers of hail or sleet in places. At Ilderton (Northumberland) the total rainfall for the month only amounted to 7mm.; at Parson Drove, Cambridgeshire, to 9mm. The duration of bright sunshine exceeded 180 hours in some districts, while Teignmouth reported 187 hours, a "record" there for March.

The avalanches which were reported on numerous occasions during the past winter in Central Europe continued during March, many reports of damage and loss of life having been received from various parts of Europe; they were especially serious at Salzburg in Austria and in Switzerland. Towards the end of the month a sudden thaw following on heavy snowfall resulted in extensive floods which caused much suffering and damage in Poland, and were responsible for the bursting of a newly-built dam in Jutland. The Vistula continued to rise until the end of the month. In some places the river was 27 ft. above the normal level, a height said not to have been recorded since 1570.

On account of torrential rain, numerous rivers in Spain and Portugal have overflowed their banks and many people have been drowned. At the end of the month a series of landslides, caused through exceptionally heavy rainfall occurred at Amalfi, Italy, and many lives were lost. In consequence of the recent heavy rain in Sinai, the railway bridge at El Arish has been washed away.

The United States were visited by two destructive storms during March. The first, on the 11th, swept the whole Atlantic seaboard, isolating Washington for hours by damaging the overhead telephone and telegraph wires and interrupting wireless operations. The second, which lasted throughout the 28th and 29th, visited chiefly the Central States. At St. Paul, in Minnesota, 18 inches of snow is said to have fallen in 24 hours. The lowlands of Ohio were flooded, and much damage done in Maryland, Pennsylvania and West Virginia.

A serious accident was caused near Bareilly (India) through a train being struck by a violent wind when crossing a bridge. The train fell into the river and many lives were lost.

The special message from Brazil states that rainfall was excessive in the north, the monthly average being 109 mm. above normal. Floods occurred in many places. In the central districts the average was 10 mm. above normal. In the south the rainfall was irregular, with an average 50 mm. under normal. Temperature was generally below normal in the north and irregular in the central and southern districts. The coffee, cotton and cocoa crops are in good condition. At Rio de Janeiro the average pressure and temperature were about normal.

Rainfall March, 1924: General Distribution

England and Wales	58	per cent. of the average 1881-1915.
Scotland	40	
Ireland	41	
British Isles	50	

Rainfall: March, 1924: England and Wales.

CO.	STATION.	In.	mm.	Per-cent. of Av
Lond.	Camden Square	·73	19	40
Sur .	Reigate, Hartswood	1·52	39	69
Kent.	Tenterden, View Tower	1·74	44	81
,, .	Folkestone, Boro. San.	1·03	26	...
,, .	Broadstairs	1·01	26	60
,, .	Sevenoaks, Speldhurst.	1·56	40	...
Sus .	Patching Farm	1·77	45	82
,, .	Eastbourne, Wilm. Sq.	1·92	49	85
,, .	Tottingworth Park	2·05	52	82
Hants	Totland Bay, Aston	1·72	44	82
,, .	Fordingbridge, Oaklnds	1·68	43	72
,, .	Portsmouth, Vic. Park.	1·43	36	72
,, .	Ovington Rectory	1·49	38	58
,, .	Grayshott	1·79	45	70
Berks	Wellington College	·91	23	46
,, .	Newbury, Greenham	1·12	28	49
Herts.	Bennington House	...	...	...
Bucks	High Wycombe	1·86	47	95
Oxf. .	Oxford, Mag. College	·87	22	57
Nor .	Pitsford, Sedgebrook	·90	23	51
,, .	Eye, Northolm	·59	15	...
Beds.	Woburn, Crawley Mill.	·69	17	39
Cam.	Cambridge, Bot. Gdns.	·63	16	43
Essex	Chelmsford, CountyLab	·73	19	...
,, .	Lexden, Hill House	·75	19	...
Suff .	Hawkedon Rectory	·51	13	27
,, .	Haughley House	·46	12	...
Norf.	Beccles, Geldeston	·63	16	37
,, .	Norwich, Eaton	·68	17	36
,, .	Blakeney	·64	16	39
,, .	Swaffham	·81	21	45
Wilts.	Devizes, Highclere	1·13	29	54
Dor .	Evershot, Melbury Ho.	2·01	51	67
,, .	Weymouth, Westham	1·51	38	73
,, .	Shaftesbury, Abbey Ho.	1·12	28	48
Devon	Plymouth, The Hoe	1·96	50	68
,, .	Polapit Tamar	2·59	66	87
,, .	Ashburton, Druid Ho.	3·28	83	74
,, .	Cullompton	2·06	53	75
,, .	Sidmouth, Sidmount	1·20	30	49
,, .	Filleigh, Castle Hill	1·72	44	...
,, .	Hartland Abbey	1·59	40	...
Corn.	Redruth, Trewirgie	2·45	62	68
,, .	Penzance, Morrab Gdn.	1·92	49	60
,, .	St. Austell, Trevarna	2·81	71	82
Soms	Chewton Mendip	1·89	48	53
,, .	Street, Hind Hayes	1·04	26	...
Glos. .	Clifton College	1·67	43	66
,, .	Cirencester	1·59	40	67
Here.	Ross, County Obsy.	·88	22	43
,, .	Ledbury, Underdown.	1·37	35	72
Salop	Church Stretton	1·26	32	53
,, .	Shifnal, Hatton Grange	1·51	38	82
Staff.	Tean, The Heath Ho.	1·31	33	56
Worc.	Ombersley, Holt Lock.	1·18	30	69
,, .	Blockley, Upton Wold.	1·11	28	52
War.	Farnborough	1·35	34	64
War.	Birminghm, Edgbaston	·93	23	49
Leics	Leicester Town Hall	·67	17	...
,, .	Belvoir Castle	·54	14	30
Rut .	Ridlington	·72	18	...
Linc.	Boston, Skirbeck	·69	17	44
,, .	Lincoln, Sessions House	·79	20	51
,, .	Skegness, Estate Office.	·57	15	34
,, .	Louth, Westgate	·65	17	31
,, .	Brigg	·97	25	53
Notts.	Worksop, Hodsock	·87	22	51
Derby	Mickleover, Clyde Ho.	·89	23	50
,, .	Buxton, Devon. Hos.	1·40	36	34
Ches.	Runcorn, Weston Pt.	·97	25	48
,, . .	Nantwich, Dorfold Hall	1·13	29	...
Lancs	Bolton, Queen's Park .	1·98	50	...
,, . .	Stonyhurst College	1·65	42	45
,, . .	Southport, Hesketh	1·15	29	52
,, . .	Lancaster, Strathspey.	1·48	38	...
Yorks	Sedbergh, Akay	2·49	63	55
,, .	Wath-upon-Dearne	·93	24	53
,, .	Bradford, Lister Pk.	1·50	38	62
,, .	Oughtershaw Hall	2·03	52	...
,, .	Wetherby, Ribston H.	1·58	40	81
,, .	Hull, Pearson Park	·98	25	54
,, .	Holme-on-Spalding	1·19	30	...
,, .	Lowthorpe, The Elms.	1·24	31	62
,, .	West Witton, Ivy Ho.	1·75	45	...
,, .	Pickering, Hungate	·89	23	...
,, .	Middlesbrough	1·01	26	64
,, .	Baldersdale, Hury Res.	1·31	33	43
Durh.	Ushaw College	1·03	26	47
Nor .	Newcastle, Town Moor.	·96	24	45
,, .	Bellingham Manor	1·03	26	...
,, .	Lilburn Tower Gdns.	·29	7	...
Cumb	Penrith, Newton Rigg.	...	...	...
,, .	Carlisle, Scaleby Hall .	1·13	29	46
,, .	Seathwaite	2·30	58	21
Glam.	Cardiff, Ely P. Stn.	1·91	49	60
,, .	Treherbert, Tynywaun	4·12	105	...
Carm	Carmarthen Friary	2·46	63	65
,, .	Llanwrda, Dolaucothy.	2·61	66	56
Pemb	Haverfordwest, Portf'd	...	...	...
Card.	Gogerddan	2·61	66	75
,, .	Cardigan, County Sch. .	1·61	41	...
Brec.	Crickhowell, Talymaes	2·25	57	...
Rad .	Birm. W. W. Tyrmynydd	2·31	59	43
Mont.	Lake Vyrnwy	2·61	66	61
Denb.	Llangynhafal	·69	17	...
Mer .	Dolgelly, Bryntirion	3·07	78	62
Carn.	Llandudno	·99	25	46
,, .	Snowdon, L. Llydaw 9	5·35	136	...
Ang .	Holyhead, Salt Island.	1·44	37	55
,, .	Lligwy	1·61	41	...
Isle of Man				
	Douglas, Boro, Cem.	2·85	73	96
Guernsey				
	St. Peter Port Grange.	2·85	73	115

Rainfall: March, 1924: Scotland and Ireland.

CO.	STATION.	In.	mm.	Per-cent. of Av.	CO.	STATION.	In.	mm.	Per-cent of Av.
Wigt.	Stoneykirk, Ardwell Ho	2·15	55	83	*Suth.*	Melvich School	2·40	61	84
,,	Pt. William, Monreith	1·86	47	...	*Caith*	Loch More, Achfary	3·11	79	48
Kirk.	Carsphairn, Shiel.	1·66	42	...	,,	Wick	1·57	40	69
,,	Dumfries, Cargen	1·51	38	42	*Ork*	Pomona, Deerness	1·56	39	55
Dum	Drumlanrig	1·40	36	38	*Shet*	Lerwick	3·22	82	103
Roxb	Branxholme	1·05	27	36	*Cork*	Caheragh Rectory	2·30	58	...
Selk	Ettrick Manse	1·06	27	...	,,	Dunmanway Rectory	1·93	49	39
Berk.	Marchmont House	·90	23	34	,,	Ballinacurra	1·30	33	46
Hadd	North Berwick Res.	·66	17	35	,,	Glanmire, Lota Lo.	1·56	40	50
Midl	Edinburgh, Roy. Obs.	1·00	25	56	*Kerry*	Valencia Obsy.	1·57	40	35
Lan	Biggar	·57	15	23	,,	Gearahameen	3·60	91	...
Ayr	Kilmarnock, Agric. C.	·78	20	28	,,	Killarney Asylum	1·78	45	38
,,	Girvan, Pinmore	·96	24	25	,,	Darrynane Abbey	1·19	30	29
Renf.	Glasgow, Queen's Pk.	·60	15	23	*Wat.*	Waterford, Brook Lo.	1·40	36	51
,,	Greenock, Prospect H.	1·67	42	34	*Tip*	Nenagh, Cas. Lough	1·03	26	33
Bute	Rothesay, Ardencraig.	1·16	29	32	,,	Tipperary	·72	18	...
,,	Dougarie Lodge	·71	18	...	,,	Cashel, Ballinamona	·84	21	31
Arg	Glen Etive	·48	12	...	*Lim*	Foynes, Coolnanes	1·53	39	52
,,	Oban	·55	14	...	,,	Castleconnell Rec.	·99	25	...
,,	Poltalloch	·72	18	19	*Clare*	Inagh, Mount Callan	2·83	72	...
,,	Inveraray Castle	·53	13	8	,,	Broadford, Hurdlest'n.	1·27	32	...
,,	Islay, Eallabus	·59	15	15	*Wexf*	Newtownbarry	1·11	28	...
,,	Mull, Benmore	·80	20	...	,,	Gorey, Courtown Ho.	·96	24	42
Kinr.	Loch Leven Sluice	1·04	26	35	*Kilk.*	Kilkenny Castle	·78	20	34
Perth	Loch Dhu	1·20	31	18	*Wic*	Rathnew, Clonmannon	1·07	27	...
,,	Balquhidder, Stronvar.	·60	15	10	*Cars.*	Hacketstown Rectory	·97	25	35
,,	Crieff, Strathearn Hyd.	·91	23	28	*QCo.*	Blandsfort House	·84	21	32
,,	Blair Castle Gardens	·56	14	...	,,	Mountmellick	·77	20	...
,,	Coupar Angus School	·65	17	30	*KCo.*	Birr Castle	·78	20	32
Forf.	Dundee, E. Necropolis	·78	20	38	*Dubl.*	Dublin, FitzWm. Sq.	·49	12	25
,,	Pearsie House	·80	20	...	,,	Balbriggan, Ardgillan	1·49	38	74
,,	Montrose, Sunnyside	·63	16	30	*Me'th*	Drogheda, Mornington	1·38	35	...
Aber.	Braemar Bank	·81	21	28	*W.M*	Mullingar, Belvedere	1·24	31	46
,,	Logie Coldstone Sch.	1·22	31	47	*Long*	Castle Forbes Gdns.	1·86	47	63
,,	Aberdeen, Cranford Ho	1·38	35	53	*Gal*	Galway, Waterdale	1·76	45	...
,,	Fyvie Castle	3·21	81	...	*Mayo*	Crossmolina, Enniscoe	...	...	...
Mor	Gordon Castle	1·31	33	56	,,	Mallaranny	2·18	55	...
,,	Grantown-on-Spey	...	...	...	,,	Westport House	1·85	47	47
Na	Nairn, Delnies	·71	18	38	,,	Delphi Lodge	3·04	77	...
Inv.	Ben Alder Lodge	·74	19	...	*Sligo*	Markree Obsy.	1·54	39	45
,,	Kingussie, The Birches	·52	13	...	*Ferm*	Enniskillen, Portora	·68	17	...
,,	Fort Augustus	·40	10	11	*Arm.*	Armagh Obsy.	1·16	29	49
,,	Loch Quoich, Loan	2·00	51	...	*Down*	Warrenpoint	1·08	27	...
,,	Glenquoich	1·00	25	10	,,	Seaforde	1·85	47	63
,,	Inverness, Culduthel R.	·87	22	...	,,	Donaghadee	1·48	38	68
,,	Arisaig, Faire-na-Squir	...	...	...	,,	Banbridge, Milltown	1·99	25	45
,,	Fort William	·53	13	8	*Antr.*	Belfast, Cavehill Rd.	2·00	51	...
,,	Skye, Dunvegan	2·41	61	...	,,	Glenarm Castle	1·91	49	...
,,	Barra, Castlebay	·87	22	...	,,	Ballymena, Harryville	1·09	28	35
R&C	Alness, Ardross Cas.	1·86	47	57	*Lon*	Londonderry, Creggan	·55	14	17
,,	Ullapool	2·96	75	...	*Tyr*	Donaghmore	1·19	30	...
,,	Torridon, Bendamph	1·74	44	23	,,	Omagh, Edenfel	·93	24	30
,,	L. Carron, Plockton	·76	19	...	*Don*	Malin Head	·51	13	22
,,	Stornoway	4·41	112	108	,,	Rathmullen	...	...	...
Suth.	Dunrobin Castle	...	...	...	,,	Dunfanaghy	·86	22	24
,,	Lairg	1·75	44	...	,,	Narin, Kiltoorish	·60	15	...
,,	Tongue Manse	2·37	60	71	,,	Killybegs, Rockmount	1·75	44	34

Foynes, February 1·68 ins., 43 mm., 53%

Climatological Table for the British Empire, October, 1923

STATIONS	PRESSURE		TEMPERATURE									PRECIPITATION			BRIGHT SUNSHINE	
			Absolute		Mean Values				Mean							
	Mean of Day M.S.L.	Diff. from Normal	Max.	Min.	Max.	Min.	½ max. and min.	Diff. from Normal	Wet Bulb.	Relative Humidity	Mean Cloud Am'nt	Am'nt	Diff. from Normal	Days	Hours per day	Percentage of possible.
	mb.	mb.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	%	0—10	mm.	mm.			
London, Kew Obsy.	1007·5	— 6·5	65	33	56·8	45·3	51·1	+ 1·2	48·8	83	7·1	135	+ 66	24	3·0	2·8
Gibraltar	1017·4	+ 2·2	82	51	73·8	62·0	67·9	+ 1·8	62·6	76	4·7	44	— 40	5	...	...
Malta	1019·0	+ 3·3	81	62	75·9	66·6	71·3	+ 1·5	64·7	73	2·4	2	— 66	2	...	...
Sierra Leone	1011·9	— 0·1	90	70	86·7	72·5	79·6	— 0·6	75·5	77	5·9	300	— 21	27	...	...
Lagos, Nigeria	1011·4	— 0·3	89	71	85·7	74·1	79·9	+ 0·8	76·1	78	7·8	136	— 60	19	...	...
Kaduna, Nigeria	1014·6	+ 2·3	96	...	87·3	...	...	...	72·2	76	2·4	71	+ 11	9	...	...
Zomba, Nyasaland	1010·8	+ 0·3	93	54	85·5	64·5	75·0	+ 0·9	...	81	4·0	12	— 26	4	...	...
Salisbury, Rhodesia	1010·9	— 0·1	97	42	88·8	53·5	71·1	+ 0·3	59·6	43	1·0	5	— 25	1	...	...
Cape Town	1016·4	— 1·0	89	49	71·4	55·0	63·2	+ 2·2	59·9	71	4·9	19	— 25	6	...	...
Johannesburg	1013·7	+ 1·6	88	35	79·5	55·3	67·4	+ 4·8	52·6	43	3·0	21	— 40	2	9·7	76
Mauritius	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Bloemfontein	...	...	96	40	84·4	55·7	70·1	+ 5·5	54·9	41	4·0	20	— 23	5	...	...
Calcutta, Alipore Obsy.	1010·5	+ 1·1	91	68	87·6	73·6	80·6	— 0·1	74·3	83	4·7	135	+ 36	5*	...	...
Bombay	1010·5	+ 0·8	93	74	89·3	77·1	83·2	+ 0·9	75·5	81	3·9	0	— 47	0*	...	...
Madras	1009·5	+ 0·6	98	71	90·0	75·2	82·6	+ 0·5	76·7	80	6·0	404	+118	13*	...	...
Colombo, Ceylon	1010·3	+ 0·5	89	68	86·0	74·2	80·1	— 0·4	77·2	72	7·8	338	— 19	26	7·2	60
Hong Kong	1013·7	+ 0·1	87	67	80·2	72·5	76·3	— 0·6	69·4	72	5·6	453	+328	8	6·9	59
Sandakan	...	...	90	74	87·8	75·3	81·5	0·0	77·1†	76†	...	122	—132	14	...	...
Sydney	1013·8	— 1·1	95	49	71·7	55·3	63·5	0·0	56·3	62	4·0	37	— 38	8	7·9	61
Melbourne	1013·1	— 1·6	84	41	65·7	49·0	57·3	— 0·3	52·8	65	7·0	93	+ 27	16	5·3	41
Adelaide	1015·6	— 0·5	90	44	69·3	52·1	60·7	— 1·2	53·1	58	6·0	56	+ 12	14	6·1	47
Perth, W. Australia	1018·1	+ 1·2	81	45	67·8	51·6	59·7	— 1·2	54·5	70	5·1	63	+ 9	14	6·6	52
Coolgardie	1015·2	0·0	95	41	78·6	50·5	64·5	+ 0·9	54·4	35	4·1	0	— 19	0	...	...
Brisbane	1015·6	— 0·5	94	51	80·8	61·2	71·0	+ 1·1	63·1	54	3·5	11	— 56	4	9·3	74
Hobart, Tasmania	1009·3	— 1·3	82	37	60·8	46·0	53·4	— 0·6	48·8	68	7·3	91	+ 34	22	5·8	44
Wellington, N.Z.	1013·5	+ 1·2	67	38	61·1	48·8	54·9	+ 0·6	50·9	75	8·0	97	— 10	16	4·3	33
Suva, Fiji	1014·7	+ 1·5	84	57	79·6	66·4	73·0	— 3·0	70·3	75	6·6	240	+ 42	16	...	...
Kingston, Jamaica	1010·7	— 1·2	95	71	89·3	73·3	81·3	+ 0·8	...	74	6·9	201	+ 11	10	...	...
Grenada, W.I.	1012·0	+ 1·0	90	74	85·4	75·5	80·5	+ 0·4	75·9	76	5·3	89	— 97	16	...	...
Toronto	1020·0	+ 2·0	69	32	57·0	40·6	48·8	+ 1·9	42·4	77	4·5	42	— 20	7	5·6	50
Winnipeg	1019·3	+ 4·0	74	12	53·9	32·9	43·4	+ 2·6	38·2	83	4·3	13	— 25	5	5·3	49
St. John, N.B.	1017·6	+ 1·1	65	30	55·5	41·4	48·5	+ 3·2	45·0	85	5·5	85	— 30	12	5·1	46
Victoria, B.C.	1017·2	— 0·4	74	41	58·4	47·1	52·7	+ 2·3	49·1	88	5·2	44	— 21	11	5·2	48

* For Indian stations a rain day is a day on which 0·1 in. (2·5 mm.) or more rain has fallen. † Mean of observations at 9h., 15h., 21h., from April, 1922.

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